WHAT IS CLAIMED IS:

1. A semiconductor device comprising at least one tailored index single mode optical amplifier

2. The semiconductor device as recited in claim 1, wherein the tailored index is produced by tailoring a current profile applied to the optical amplifier.

3. The semiconductor device as recited in claim 2, wherein the current profile is tailored along the optical axis of the optical amplifier.

4. The semiconductor device as recited in claim 2, wherein the current profile is tailored along at least two of the axes of the optical amplifier.

5. The semiconductor device as recited in claim 1, further comprising a heat sink, wherein the tailored index associated with the optical amplifier is produced by varying the thermal impedance characteristic of the junction at the heatsink.

6. The semiconductor device as recited in claim 1, wherein the tailored index associated with the optical amplifier is provided by implantation of impurities in regions of the semiconductor device adjacent to the optical amplifier.

7. The semiconductor device as recited in claim 1, wherein the tailored index associated with the optical amplifier is produced by varying the height of a buried rib along the optical axis as the width varies from a first to a second predetermined value.

8. The semiconductor device as recited in claim 1, wherein the tailored index associated with the optical amplifier is produced by varying the height of a surface rib along the optical axis as the width varies from a first to a second predetermined value.

9. The semiconductor device as recited in claim 1, wherein the tailored index associated with the optical amplifier is produced by varying at least two of:

a current profile applied to the optical amplifier;

the thermal impedance characteristic of a junction between the optical amplifier and a heatsink thermally coupled thereto;

impurity densities in regions of the semiconductor device adjacent to the optical amplifier;

the height of a buried rib along the optical axis as the width varies from a first to a second predetermined value; and

the height of a surface rib along the optical axis as the width varies from a first to a second predetermined value.

10. A semiconductor device comprising: √

at least one tailored index single mode optical amplifier;

an input waveguide for coupling an optical signal into the optical amplifier; and

an output waveguide for coupling an amplified signal out of the optical amplifier.

11. The semiconductor device as recited in claim 10, wherein the output waveguide comprises an optical element for extracting the amplified signal out of a surface parallel to the optical axis of the optical amplifier.

12. The semiconductor device as recited in claim 11, wherein the optical element comprises a turning mirror.

13. The semiconductor device as recited in claim 11, wherein the optical element comprises a diffraction grating.

14. The semiconductor device as recited in claim 10, wherein the input waveguide comprises a tailored index waveguide.

15. The semiconductor device as recited in claim 10, wherein the input waveguide comprises a tapered waveguide.

16. The semiconductor device as recited in claim 10, wherein:

the semiconductor device comprises epitaxial layers; and

at least one of the input and output waveguides couples one of the optical signal and the amplified signal at a boundary plane of the optical amplifier intersecting the epitaxial layers.

17. The semiconductor device as recited in claim 16, wherein the boundary plane is not perpendicular to the optical axis of the optical amplifier.

18. A semiconductor device comprising:

a tailored index single mode optical amplifier including means for tailoring a structural characteristic associated with the optical amplifier to thereby provide the tailored index;

first coupling means for coupling an optical signal into the optical amplifier; and

second coupling means for coupling an amplified signal out of the optical amplifier.

19. The semiconductor device as recited in claim 18, wherein at least one of the first and second coupling means comprises an optical fiber.

20. The semiconductor device as recited in claim 18, wherein at least one of the first and second coupling means comprises a free space optical path portion.

21. The semiconductor device as recited in claim 18, wherein at least one of the first and second coupling means comprises a phase modulator.

22. A semiconductor laser device, comprising:

an optical phased array having N optical power amplifiers optically coupled to one another in parallel, wherein:

each of the N power amplifiers is a tailored index single mode guided power amplifier; and

N is an integer greater than or equal to 2.

23. The semiconductor device as recited in claim 22, wherein each of the N tailored index single mode power amplifiers have:

a buried rib structure; and

exhibit a continuous taper in the index profile.

24. The semiconductor device as recited in claim 22, wherein each of the N tailored index single mode power amplifiers have:

a buried rib structure; and

exhibit a discontinuous variation in the index profile that produces a cumulative predetermined index profile.

25. The semiconductor device as recited in claim 22, wherein each of the N tailored index single mode power amplifiers have:

a surface rib structure; and

exhibit a continuous variation in the index profile.

26. The semiconductor device as recited in claim 22, wherein each of the N tailored index single mode power amplifiers have:

a surface rib structure; and

exhibit a discontinuous variation in the index profile that produces a cumulative predetermined index profile.

26. The semiconductor device as recited in claim 22, wherein the current profile applied to the amplifier structures is varied to tailor the index of the power amplifier

27. The semiconductor device as recited in claim 22, further comprising a heat sink, wherein the tailored index step of the power amplifiers is provided by varying the thermal impedance characteristic of the junction at the heatsink .

28. The semiconductor device as recited in claim 22, wherein the tailored index step of the power amplifiers is provided by implanting impurities in regions of the semiconductor device adjacent to the power amplifier.

29. The semiconductor device as recited in claim 22, wherein:

the N power amplifiers are disposed in an array of M x R power amplifiers:

M and R are both positive integers; and

N is equal to the product of M times R.

30. The semiconductor laser device as recited in claim 29, wherein:

all of the N power amplifiers receive an input signal from a single master oscillator; and

the N output beams are coherent with respect to one another.

31. The semiconductor laser device as recited in claim 29, wherein:

a first M of the N power amplifiers receive an input beam from an R^{th} master oscillator;

a second M of the N power amplifiers receive an input beam from an R^{th-1} master oscillator; and

all of the output beams generated by the first M of the N power amplifiers are coherent with respect to one another but incoherent with respect to the output beams generated by the second M of the N power amplifiers.

32. The semiconductor device as recited in claim 22, further comprising:

an optical device for optimizing the fill factor of the phased array output beam synthesized from the outputs of the N power amplifiers.

33. The semiconductor device as recited in claim 22, further comprising:

N phase modulators optically coupled to the N power amplifiers, respectively; and

a control system controlling the N phase modulators to thereby phase align each output signal generated by the N power amplifiers.

34. The semiconductor device as recited in claim 33, wherein the control system implements a hill climbing algorithm .

35. The semiconductor device as recited in claim 33, wherein the control system implements an interferometric phase control algorithm.

36. The semiconductor device as recited in claim 22, further comprising:

N-1 phase modulators optically coupled to N-1 of the N power amplifiers, respectively; and

a control system controlling the N-1 phase modulators to thereby phase align each output signal generated by the N-1 of the N power amplifiers.

37. The semiconductor device as recited in claim 36, wherein the control system implements a hill climbing algorithm .

38. The semiconductor device as recited in claim 36, wherein the control system implements an interferometric phase control algorithm.

39. A high power laser system comprising a plurality of the semiconductor laser devices recited in claim 22.

40. The high power laser system as recited in claim 33, wherein the phased aligned output of the semiconductor laser device is transmitted by a single optical fiber.

5

41. An integrated semiconductor device which generates N phase aligned, wavefront matched laser beams from N amplified laser beams; comprising:

N phase modulators receiving the an input beam from a master oscillator and generating N phase shifted laser beams; and

N tailored index single mode power amplifiers receiving the N phase shifted laser beams and generating the N amplified laser beams,

a phase sensor generating N sensor signals indicative of the phase of the individual N amplified laser beams; and

a controller for controlling the phase of each of the N amplified laser beams responsive to the N sensor signals, respectively, to thereby generate the N phase aligned, wavefront matched laser beams,

where N is a positive integer.

6

42. An integrated semiconductor device which generates N phase aligned, wavefront matched laser beams from N amplified laser beams; comprising:

N -1 phase modulators receiving the an input beam from a master oscillator and generating N-1 phase shifted laser beams; and

N tailored index single mode power amplifiers receiving the N-1 phase shifted laser beams and the input beam and generating the N amplified laser beams,

a phase sensor generating N-1 sensor signals indicative of the phase of the individual N-1 amplified laser beams; and

a controller for controlling the phase of each of the N-1 amplified laser beams responsive to the N-1 sensor signals, respectively, to thereby generate the N phase aligned, wavefront matched laser beams,

where N is a positive integer greater than or equal to 2.

43. A semiconductor laser system, comprising:

N tailored index single mode power amplifiers;

L phase modulators optically coupled to the input ports of L of the N tailored index single mode power amplifiers;

an optical device which launches the output of the N tailored index single mode power amplifiers into an optical fiber to thereby generate a coherent beam;

a phase sensor for generating respective electrical signals indicative of phase and wavefront characteristic each of L of the N coherent beams; and

a controller electrically coupled to the L phase modulators for permitting the L phase modulators to match the phase and wavefront of the L of the N coherent beams to one another, where L and N are positive integers and N is greater than or equal to L.

44. The semiconductor laser system as recited in claim 43, further comprising:

an optical tap for routing a predetermined portion of the N coherent beams to a sensor output port; and

a power sensor optically coupled to the sensor output port for measuring the output of the semiconductor laser system.

45. A two-dimensional semiconductor laser array, comprising:

an optical phased array having N power amplifiers optically coupled to one another in parallel, wherein:

each of the N power amplifiers is a tailored index single mode guided power amplifier;

the N power amplifiers are disposed in an R linear arrays of power amplifiers, each linear array including M power amplifiers:

M and R are both positive integers; and

N is equal to the product of M times R.

46. The two-dimensional semiconductor laser array as recited in claim 45, wherein:

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all of the N power amplifiers receive an input beam from a single master oscillator; and

the N output beams are coherent with respect to one another.

47. The two-dimensional semiconductor laser array as recited in claim 45, wherein:

an R^{th} linear array of power amplifiers receives an input beam from an R^{th} master oscillator;

an R^{th-1}linear array of power amplifiers receive an input beam from an R^{th-1} master oscillator; and

all of the output beams generated by the Rth linear array of power amplifiers are coherent with respect to one another but incoherent with respect to the output beams generated by the R^{th-1} linear array of power amplifiers.

48. A semiconductor device comprising:

an optical phased array having N output amplifiers, wherein:

each of the output amplifiers is a tailored index single mode amplifier,

the N output amplifiers are disposed on a single substrate, and

N is an integer equal to or greater than 2.

49. The semiconductor device as recited in claim 48, wherein the N tailored index single mode output amplifiers are disposed in a linear array.

50. The semiconductor device as recited in claim 49, wherein at least one of the input and output regions of the semiconductor device associated with the linear array correspond to a facet of the semiconductor device exposing the epitaxial layers of the semiconductor device.

51. The semiconductor device as recited in claim 48, wherein the N tailored index single mode output amplifiers are disposed in a two-dimensional planar array.

52. The semiconductor device as recited in claim 51, wherein the semiconductor device further comprises coupling elements for coupling optical signals one of into and out of the surface of the semiconductor device.

53. The semiconductor device as recited in claim 48, wherein each of the N optical amplifiers is optically coupled to one of a surface emitter or a receptor disposed on a layer of the semiconductor device.

54. A semiconductor device comprising:

a distribution network receiving an optical source signal and generating N distributed signals;

N-1 phase modulators receiving N-1 of the N distributed signals and generating N-1 phase modulated signals;

an optical phased array having N output amplifiers, each of the N optical amplifiers receiving one of the N-1 phase modulated signals or the N distributed signals, wherein:

each of the output amplifiers is a tailored index single mode amplifier,

the N output amplifiers, the N-1 phase modulators, and the distribution network are disposed on a single substrate, and

N is an integer equal to or greater than 2.

55. The semiconductor device as recited in claim 54, wherein the N tailored index single mode output amplifiers are disposed in a linear array.

56. The semiconductor device as recited in claim 55, wherein at least one of the input and output regions of the semiconductor device associated with the linear array correspond to a facet of the semiconductor device exposing the epitaxial layers of the semiconductor device.

57. The semiconductor device as recited in claim 54, wherein each of the N-1 phase modulators increases the collimation of the individual optical outputs of N-1 of the N output amplifiers.

58. The semiconductor device as recited in claim 54, wherein the N-1 phase modulators collectively improve the geometric fill factor of the combined optical outputs of the N output amplifiers.

59. The semiconductor device as recited in claim 54, wherein the N tailored index single mode output amplifiers are disposed in a two-dimensional planar array.

60. The semiconductor device as recited in claim 59, wherein the semiconductor device further comprises coupling elements for coupling optical signals one of into and out of the surface of the semiconductor device.

61. The semiconductor device as recited in claim 59, wherein each of the N optical amplifiers is optically coupled to one of a surface emitter or a receptor disposed on a layer of the semiconductor device.

62. The semiconductor device as recited in claim 59, wherein each of the N-1 phase modulators increases the collimation of the individual optical outputs of N-1 of the N output amplifiers.

63. The semiconductor device as recited in claim 54, wherein the N-1 phase modulators collectively improve the geometric fill factor of the combined optical outputs of the N output amplifiers.

64. A semiconductor device comprising:

a master oscillator generating an optical source signal;

a distribution network receiving the optical source signal and generating N distributed signals;

N-1 phase modulators receiving N-1 of the N distributed signals and generating N-1 phase modulated signals;

an optical phased array having N output amplifiers, each of the N optical amplifiers receiving one of the N-1 phase modulated signals or the N distributed signals, wherein:

each of the output amplifiers is a tailored index single mode amplifier,

the N output amplifiers, the N-1 phase modulators, the distribution network, and the master oscillator are all disposed on a single substrate, and

N is an integer equal to or greater than 2.

65. The semiconductor device as recited in claim 64, wherein the N tailored index single mode output amplifiers are disposed in a linear array.

66. The semiconductor device as recited in claim 65, wherein at least one of the input and output regions of the semiconductor device associated with the linear array correspond to a facet of the semiconductor device exposing the epitaxial layers of the semiconductor device.

67. The semiconductor device as recited in claim 64, wherein each of the N-1 phase modulators increases the collimation of the individual optical outputs of N-1 of the N output amplifiers.

68. The semiconductor device as recited in claim 64, wherein the N-1 phase modulators collectively improve the geometric fill factor of the combined optical outputs of the N output amplifiers.

69. The semiconductor device as recited in claim 64, wherein the N tailored index single mode output amplifiers are disposed in a two-dimensional planar array.

70. The semiconductor device as recited in claim 69, wherein the semiconductor device further comprises coupling elements for coupling optical signals one of into and out of the surface of the semiconductor device.

71. The semiconductor device as recited in claim 69, wherein each of the N optical amplifiers is optically coupled to one of a surface emitter or a receptor disposed on a layer of the semiconductor device.

72. The semiconductor device as recited in claim 69, wherein each of the N-1 phase modulators increases the collimation of the individual optical outputs of N-1 of the N output amplifiers.

73. The semiconductor device as recited in claim 64, wherein the N-1 phase modulators collectively improve the geometric fill factor of the combined optical outputs of the N output amplifiers.

74. A laser system comprising:

an optical phased array of N tailored index single mode amplifiers;

N-1 phase modulators disposed upstream of selected ones of the N tailored index single mode amplifiers,

an optical signal source producing an optical signal,

a distribution network for distributing the optical signal to the selected ones of the N-1 phase modulators,

a controller for generating N-1 control signals;

interface circuitry for applying the N-1 control signals to the N-1 phase modulators to effect control; and

means for measuring a parameter characteristic of selected ones of the output signals produced by the N tailored index single mode amplifiers,

wherein N is an integer equal to or greater than 2.

75. The laser system as recited in claim 74, wherein the N tailored index single mode amplifiers, the N-1 phase modulators, and a portion of the distribution network are supported by a single support element maintaining the N tailored index single mode amplifiers, the N-1 phase modulators, and a portion of the distribution network in thermal equilibrium.

76. The laser system as recited in claim 75, wherein the distribution network includes a free space portion.

77. The laser system as recited in claim 74, wherein the N tailored index single mode amplifiers, the N-1 phase modulators, a portion of the distribution network, and the interface circuitry are supported by a single support element maintaining the N tailored index single mode amplifiers, the N-1 phase modulators, a portion of the distribution network, and the interface circuitry in thermal equilibrium.

78. The laser system as recited in claim 74, wherein the N tailored index single mode amplifiers, the N-1 phase modulators, a portion of the distribution network, the controller, and the interface circuitry are supported by a single support element maintaining the N tailored index single mode amplifiers, the N-1 phase modulators, a portion of the distribution network, the controller, and the interface circuitry in thermal equilibrium.

79. The laser system as recited in claim 74, wherein the N tailored index single mode amplifiers, the N-1 phase modulators, a portion of the distribution network, the controller, the optical signal source, and the interface circuitry are supported by a single support element maintaining the N tailored index single mode amplifiers, the N-1 phase modulators, a portion of

the distribution network, the controller, the optical signal source, and the interface circuitry in thermal equilibrium.

80. The laser system as recited in claim 74, wherein:

the measuring means measures the *near*-field phase pattern produced by the N tailored index single mode amplifiers, and

the controller optimizes the far-field emission of the N tailored index single mode amplifiers by appropriately controlling the N – 1 phase modulators associated with the N tailored index single mode amplifiers.

81. The laser system as recited in claim 74, wherein:

the measuring means generates measurement signals representing the relative phases of the output signals of the N tailored index single mode amplifiers to one of each other and a common phase reference signal, and

the controller optimizes the far-field emission of the N tailored index single mode amplifiers by appropriately controlling the N – 1 phase modulators associated with the N tailored index single mode amplifiers.

82. The laser system as recited in claim 74, wherein:

the measuring means measures the power generated by the N tailored index single mode amplifiers incident on a remote target, and

the controller maximizes the power from the N tailored index single mode amplifiers incident on the target by appropriately controlling the N – 1 phase modulators associated with N tailored index single mode amplifiers.

83. The laser system as recited in claim 74, wherein:

the measuring device measures the power coupled from the semiconductor device into an optical fiber, and

the controller maximizes the power from the N tailored index single mode amplifiers coupled into the optical fiber by appropriately controlling the N-1 phase modulators associated with the N tailored index single mode amplifiers.

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